DOCUMENT RESUME

ED 311 050 TM 013 605

AUTHOR Perkins, Kyle; Duncan, Ann
TITLE The Determination of Prerequisite Relationships in a Standardized Usage and Expression Test.
PUB DATE 86
NOTE 23p.
PUB TYPE Reports - Research/Technical (143)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *Elementary School Students; *Expressive Language; Grade 6; Instructional Development; Intermediate Grades; Item Analysis; Language Tests; *Language Usage; Latent Trait Theory; Organization; *Prerequisites; Standardized Tests; *Standard Spoken Usage; Syntax
IDENTIFIERS *Iowa Tests of Basic Skills; *Ordering Theory

ABSTRACT

Item responses from a standardized language arts usage and expression test were submitted to an ordering-theoretic data analysis procedure to identify the significant prerequisite relationships that underlay the data set. Responses were elicited from a sample of 81 sixth graders who took the Iowa Tests of Basic Skills, Form G, Level 12 usage and expression test, which contains 22 usage items and 18 expression items. The test assesses 28 skills objectives that fall into seven major categories (conciseness and clarity; appropriateness; organization; and use of verbs, pronouns, modifiers, and context). Ordering theory, which is defined as an approach to fundamental measurement that has as its intent the definition of the best fitting linear or non-linear hierarchical network among a series of tests, was the basis for the analysis. It is a deterministic measurement model that uses task response patterns to identify both linear and non-linear qualitative, prerequisite relations among tasks or behaviors. In general, it was found that success with paradigmatic elements was a prerequisite for success with syntagmatic units. The paper concludes with an illustration of the means by which ordering-theoretic results can be used in instructional design. Three figures and two data tables are included. (TJH)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ED311050

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

☑ This document has been reproduced as received from the person or organization originating it.

☐ Minor changes have been made to improve reproduction quality.

• Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY

KYLE PERKINS

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

The Determination of Prerequisite Relationships in a Standardized Usage and Expression Test

Kyle Perkins
Southern Illinois University

and

Ann Duncan, Principal
Carterville (IL) Grade School

(RUNNING HEAD: Prerequisite Relationships)

Department of Linguistics
Southern Illinois University
Carbondale, IL 62901-4517

TM013605

BEST COPY AVAILABLE

Abstract

Item responses from a standardized language arts usage and expression test were submitted to an ordering-theoretic data analysis procedure to identify the significant prerequisite relationships which underlay the data set. In general, it was found that success with paradigmatic elements was a prerequisite for success with syntagmatic units. The paper concludes with an illustration of how ordering-theoretic results can be utilized in instructional design.

Introduction

The purpose of the research reported in this paper was to identify the prerequisite relationships which exist in the item responses elicited from a sample of sixth-graders who sat for the Iowa Tests of Basic Skills Form G, Level 12 usage and expression test (Hieronymous, Hoover, and Lindquist, 1986a). The impetus for conducting this research was to determine whether the mastery of one usage or expression skill objective is a prerequisite to the mastery of two or more usage and/or expression skill objectives, or conversely, whether the mastery of two or more usage and/or expression skill objectives is a prerequisite to the mastery of one higher-order usage or expression skill objective. In the context of this research Gagne's (1977) definition of prerequisite is employed: "a capability of prior learning which is incorporated into new learning. The previously learned entity actually enters into the newly learned capability, becomes and remains a part of the behavior which results from the events of learning" (p. 268).

The results of this research were intended to augment the corpus of systematic research on elementary school children's attained proficiency in usage and expression skills objectives and to provide an illustration of how data on prerequisite relationships can be utilized in elementary school instructional design.

Data from a prerequisite relationship study can provide useful information about students' entering behavior (in the next school year), and Gagne (1977) emphasizes the essential nature of the students' entering behavior as a crucial element to be considered in instructional design. Gagne (1977) suggests the following characteristics of previously learned capabilities: they (1) must be retrievable from long-term memory; (2) must be readily accessible; (3) may support new learning; and (4) may be incorporated into

new learning. Thus, the determination of prerequisite relationships in a standardized usage and expression test may provide some insight into the acquisition of such skills objectives by sixth-grade students and may prove useful in the design of one component of language arts instructional delivery.

This research employed ordering theory as the principal data analysis procedure (Airasian and Bart, 1975; Bart and Krus, 1973; Bart, Frey, and Baxter, 1979). Airasian and Bart (1975) define ordering theory as "an approach to fundamental measurement which has as its intent the definition of the best fitting linear or non-linear hierarchical network among a series of tasks....a deterministic measurement model which uses task response patterns to identify both linear and non-linear qualitative, prerequisite relations among tasks or behaviors" (p. 166). Ordering theory is a particularly useful tool for learning research because Gagne (1977) has reported that groups of tasks or skills objectives are likely to form branched, hierarchical, non-linear networks rather than hierarchical, linear networks.

Bart and his colleagues consider task A to be a prerequisite to task B to the extent that the (01) response pattern does not occur, where 0 represents a "fail" on task A and 1 represents a "pass" on task B. In other words, the (01) response pattern is disconfirmatory to the extent that a correct response for task A is a prerequisite to a correct response for task B. As Bart and Krus (1973) have noted, the (00), (10), and (11) response patterns are confirmatory for the defining statement specifying the prerequisite relationship: success on task A is a prerequisite to success on task B if and only if the response pattern (01) for tasks A and B respectively does not occur.

Data submitted to an ordering-theoretic analysis must meet two criteria:

(1) all items must be scored dichotomously; and (2) all subjects in the sample must respond to all items. It is further assumed that a correct response to an item reflects a manifestation of the underlying latent trait which is being assessed.

Method

Subjects

The subjects who generated the data for this research were 81 sixth-grade students enrolled in a municipal school system. The method of selection was the natural assembly process. All students who sat for the examination were included in the sample save for those who did not respond to all of the items.

Instrumentation

The Iowa Tests of Basic Skills (Hieronymus, Hoover, and Lindquist, 1986a) is the standardized achievement battery which is used in the school's yearly assessment program. The Form G, Level 12 usage and expression test contains 40 items: 22 usage items and 18 expression items. According to Hieronymus, Hoover, and Lindquist (1986b), twenty-eight skills objectives are assessed, and they are classified into seven major categories: "use of verbs, use of pronouns, use of modifiers, use of context, conciseness and clarity, appropriateness, and organization. The skills are all concerned with 'standard' English usage. The situations are sampled from both formal and informal written materials" (p. 54).

Procedures

A contingency table was constructed for each of the 1,560 (40 x 40 - 40 = 1,560) item pairs, and a zero tolerance level was established. In this context, zero tolerance means that if, for any item pair generically labelled AB, a single occurrence of an (01) response pattern was found, the prerequisite relationship that success on task A is necessary for success on task B was disconfirmed for that particular item pair.

After all the prerequisite relationships had been identified, they were submitted to a statistical test developed by Bart and Read (1984) to determine whether the previously identified prerequisite relationships occurred by chance. Ordering-theoretic procedures per se cannot indicate whether a prerequisite relationship occurs by chance or not. It was therefore necessary for Bart and his colleagues to develop a statistical test to assess the strength of the identified prerequisite relationships.

Bart and Read (1984) note that the ordering-theoretic procedure is insensitive to item difficulty and that "if item i is an extremely easy item and item j is an extremely difficult item, then intuitively one would expect that most respondents would get item i correct and item j incorrect. This pairing of item difficulties could lead to an inflated occurrence of allowable response patterns (00, 10, and 11) and a deflated occurrence of the disallowable response pattern (01), producing the finding of a prerequisite relationship, when in fact no relationship existed" (p. 224).

(Put Appendices A and B about here)

Bart and Read's (1984) statistical test uses the table of notation

for response patterns (Appendix A) and the unit normal deviate approximation associated with Fisher's exact test; the formula for the unit normal deviate approximation is also included (Appendix B). The unit normal deviate approximation is in reality a *z* value, and the criterion level for significance was set in advance at the .05 level. In other words, the test statistic produced by the formula in Appendix B for each prerequisite relationship had to equal or exceed 2.326 in order to be considered significant.

Results

Prerequisite relationships were found to exist between 21 of the 1,560 item pairs, 17 of which were significant at the .05 level. Fourteen of the significant prerequisite relationships were significant at the .01 level with the highest *z* value being 4.724; the lowest non-significant *z* value for an identified prerequisite relationship was .805.

(Put Table 1 about here)

Table 1 presents the item number and descriptor (taken from Hieronymus, Hoover, and Lindquist, 1986b) for each of the 19 items that entered a significant prerequisite relationship.

(Put Table 2 about here)

Table 2 displays the hierarchical linear and branched, hierarchical, non-linear networks which the identified significant prerequisite relationships formed.

The A items in the "success on task A is a prerequisite for success

on task B" definition statement were significantly easier than the B items. The average item difficulty (calculated as the proportion of correct responses) for the A items was .905 with a range of .81 to .95. The average item difficulty for the B items was .636 with a range of .43 to .80. The Mann-Whitney U-test, a nonparametric alternative to the t-test for two independent samples, indicated that higher ranks were associated with the A items' difficulty indices, a difference which was significant at the .01 level for a one-tailed test. For this reason, detailed descriptions of the items which entered the significant prerequisite relationships will be offered.

No significance is to be attached to the numbers given to the significant prerequisite relationships shown in Table 2; the numbers are for reference purposes only.

Prerequisite Relationship 1

Item 25 required the subjects to recognize the use of an incorrect personal pronoun case form, the absolute form of a personal pronoun which should be used without a following noun, but which was followed by a noun in the question stimulus. There was one additional case form item in the test, and it concerned the difference between nominative and objective case marking.

Item 87 asked the subjects to indicate the best way to rewrite the components of a complete predicate. The task entailed that the subjects recognize the correct order of two adverbial modifiers found in a predicate containing the two adverbs, a transitive verb, and a direct object. The citation contained no mistakes. The other word-order item in the test involved the placement of time and location adverbs in a transitive, active predicate.

For prerequisite relationship 1, success in the identification of the correct case of a personal pronoun was necessary for success in the placement of two adverbs into their proper slots in a complete predicate.

Prerequisite Relationship 2

Item 71 required the students to supply the future perfect tense, i.e., will have Ved, in the context of an activity that will have been completed by a future point in time which was supplied by an adverbial modifier. The other verb tense item in the test involved tense sequence for the main verbs in a complex sentence with a main clause and a subordinate clause.

Item 41 involved the identification of the incorrect use of a nominative case personal pronoun being used as the object of a preposition. The prepositional phrase containing the incorrect pronoun case form was found in an embedded noun clause which functioned as the direct object of the main clause. The other case form item in the test was item 25.

For prerequisite relationship 2 success in identifying the function and form of the future perfect tense in a simple sentence with one main clause was necessary for success in identifying an incorrect pronoun case form deeply embedded in a complex sentence.

Prerequisite Relationship 3

Prerequisite relationship 3 is a complicated piece of work in that it is a good example of a branched, hierarchial network. Success on four items (32, 36, 39, and 80) was necessary for success on a single item (38).

Success on two of the four items (36 and 39) was necessary for success on a different, single item (88).

Item 32 involved the recognition of an ungrammatical form of the past tense form (second principal part) of an irregular, strong verb in a simple sentence. There was only one past tense verb form item in the test.

Item 36 contained two modal auxiliary verbs (a holophrastic modal and a periphrastic modal) within the same simplex sentence. It is the case that in some regions of the Southern Midlands dialect these two modals are frequently used together in informal, nonstandard speech. The other redundancy item contained an unnecessary, incorrect deictic adverb which had undergone a functional shift to become an adjective.

Item 39 presented a double negative in a main clause: the negative adverb and the pronoun no one. The main clause was modified by a relative clause. The other double negative item contained the negative contraction followed by nowhere in a single sentence.

Item 80 required the students to identify a grammatically correct and complete sentence from a group of psuedo-"sentences" which consisted of fragments, run-ons, and phrases. The second sentence structure-complete sentences item was quite similar to item 80.

Item 38 tested the students' ability to locate the head noun (which was plural) in a complete subject and to recognize that there was a lack of subject-verb agreement. The predicate consisted of the copulative be followed by a plural predicate nominal. The other subject-verb agreement test item (26) also required the identification of the head noun, which was singular, and to recognize the lack of number concord. The essential subject in item 26 was modified by a prepositional phrase whose object

was plural and stood contiguous to the verb.

Item 40 assessed the ability to identify the incorrect form of a past participle of an irregular, strong verb which correctly undergoes vowel mutation to form its third principal part. In addition, the sentence was in the passive voice, and the verb was an inseparable two-word verb. The second past participle item, which did not enter a prerequisite relationship, also involved an irregular, strong verb, but the stimulus sentence containing it lacked the syntactic complexity and enhancement which item 40 exhibited.

Item 83 presented a paragraph followed by "Which sentence should be left out of this paragraph?" The students had to identify the irrelevant sentence which detracted from the paragraph's coherence. Item 83 could well have been found in a reading comprehension test. The remaining appropriateness item, which did not enter into a prerequisite relationship, asked the students to select a formal appropriate paragraph for a business request from three informal paragraphs with the same content.

Item 84 presented a paragraph followed by "Where is the best place for sentence 3?" In order to determine the best location for sentence 3, the students had to notice that sentence 3 contained a noun phrase which presented new information which was signalled by the use of the indefinite article a. Sentence 4 repeated this information as old information which was signalled by the use of the definite article the. Item 84 has all the appearance of a reading comprehension item whose purpose is to assess cohesive ties.

Item 35 contained an adverb in the comparative degree which modified a monosyllabic adjective. In other words, the ADJ-er form should have been used instead of more ADJ. The second comparative form test item,

which did not enter a prerequisite relationship, was similar to item 35.

Item 76, a sentence structure item, assessed the correct order of time, manner, and locative adverbs in a predicate. The other sentence structure item involving adverbs was item 87 which also entered a prerequisite relationship and involved fewer adverbs.

Item 77, a conciseness item, required the subjects to choose a sentence which contained a compound, coordinate plural subject noun phrase in a simple sentence as opposed to a selection of compound sentences which disrupted the coordinate sense of the compound subject. Item 77 was the only conciseness item in the test.

Item 78 offered the subjects a choice of three sentences with dangling present participle modifiers and the correct response which had the present participle appropriately and correctly modifying the subject.

Item 85, a sentence function item, offered the following task based on a short paragraph: "Choose the best topic sentence for this paragraph." This item appears to be a reading comprehension item which entails a higher-order inference task. The other sentence function item in the test, which did not enter a prerequisite relationship, asked the students to choose the best concluding sentence for the same paragraph on which item 85 was based. The concluding sentence item did not require the same higher-order processing as item 85 because the options simply repeated and paraphrased the contents of the paragraph.

Item 88 tested the students' understanding of parallel constructions. The stimulus sentence contained a prepositional phrase with two noun phrase objects and a gerund object. To answer the item correctly, the students were to indicate that the gerund did not fit the collocation pattern established by the first two objects. Item 88 was the only item of its kind in the test.

Discussion

The results of this investigation indicate that for this sample of sixth-graders who sat for the Iowa Tests of Basic Skills usage and expression test success on case forms; verb tenses; redundancies; double negatives; and the structure of complete sentences was a prerequisite for success on sentence word order; case forms within prepositional phrases; subject-verb agreement; conciseness; misplaced modifiers; sentence function; parallel constructions; comparative and superlative forms; the past participle forms of strong verbs; and suitability of sentences and style to purpose, as these skills objectives are assessed by the Iowa Tests of Basic Skills.

The first set of tasks, i.e., case forms, verb tenses, etc. can generally be classified as paradigmatic linguistic elements: those items which have to do with the declension, conjugation, and inflectional forms of a word. For those readers who are familiar with the term slot-and-filler grammar, most of these paradigmatic elements are fillers (lexical items or phrases) which are placed into different slots. This view of grammar defines sentence patterns as a sequence of slots into which specific fillers are placed. The only counterexample to the generalization was item 80 which required the students to identify a grammatically correct and complete sentence.

The second set of tasks, i.e., sentence word order, subject-verb agreement, etc. can generally be classified as syntagmatic linguistic elements: those elements which are related to the organization and relationship of sentence constituents. Syntagmatic units are related to the slots (and their patterning) of a slot-and-filler grammar. There were two counterexamples to the generalization concerning the second set of tasks:

item 40 which assessed a past participle and item 35 which assessed the comparative form of adverbs. If, however, one considers the fact that each of these elements has co-occurrence restrictions with other elements within a sentence, one could then properly classify these items as syntagmatic units.

A note of caution is merited at this juncture. The intent of this paper is not to generalize the findings reported here to the entire universe of sixth-grade pupils. With other samples of sixth-grade students having sat for other standardized achievement tests, the results in terms of significant prerequisite relationships may be quite different. However, these results could provide a hypothesis for further research with ordering-theoretic procedures: that success with paradigmatic units is necessary for success with syntagmatic units.

In the context of Gagne's (1977) research, we can report that for this sample of sixth-grade students, there is evidence that mastery of paradigmatic units was a prerequisite for success with syntagmatic units. By using ordering-theoretic methods, language arts teachers can determine which usage and expression skills objectives comprise new learning and, thus, they can tailor the following year's instruction vis-a-vis prerequisite relationships, thereby fitting the language arts curriculum to the students instead of fitting the students to the language arts curriculum.

The evidence from this research indicates that this particular cohort could benefit from additional instruction on the syntagmatic units listed in the second set of tasks. The syntagmatic tasks could be taught from start to finish, in a linear approach, with each task being covered thoroughly at the prescribed time. Another possibility is to use a spiralling, cyclical syllabus design in which these tasks would be recycled from time to time.

Previously learned material could be reviewed by contrasting the form and the function of the new material with the old material. A cyclical syllabus capitalizes on the cognitive skills which the students already possess, an approach advocated in the general theoretical principles of cognition (e.g., Bruner, Olver, and Greenfield, 1966).

References

Airasian, P. W., & Bart, W. M. (1975). Validating a priori instructional hierarchies. Journal of Educational Measurement, 12, 163-173.

Bart, W. M., & Krus, D. J. (1973). An ordering-theoretic method to determine hierarchies among items. Educational and Psychological Measurement, 33, 291-300.

Bart, W. M., Frey, S., & Baxter, J. (1979). Generalizability of the ordering among five formal reasoning tasks by an ordering-theoretic method. Child Study Journal, 9, 251-259.

Bart, W. M., & Read, S. A. (1984). A statistical test for prerequisite relations. Educational and Psychological Measurement, 44, 223-227.

Brownlee, K. (1965). Statistical theory and methodology in science and engineering. New York: Wiley.

Bruner, J. S., Olver, R., & Greenfield, P. (1966). Studies in cognitive growth. New York: Wiley.

Gagne, R. M. (1977). The conditions of learning (third edition). New York: Holt, Rinehart and Winston.

Hieronymus, A. N., Hoover, H.D., & Lindquist, E. F. (1986a). Iowa tests of basic skills, Form G, Level 12. Chicago: The Riverside Publishing Company.

Hieronymus, A. N., Hoover, H.D., & Lindquist, E. F. (1986b). Preliminary teacher's guide. Multilevel battery. Levels 9-14. Chicago: The Riverside Publishing Company.

Appendix A
Table of Notation for Response Patterns for Two Dichotomously Scored Items, A and B

		Item B		
		1	0	
Item A	1	n_{11}	n_{12}	$n_{1.}$
	0	n_{21}	n_{22}	$n_{2.}$
		$n_{.1}$	$n_{.2}$	

(Bart and Read, 1984, p. 225)

Appendix B
Unit Normal Deviate Approximation

$$u = \frac{n_{11} - \frac{n_{1.} n_{.1}}{n}}{\left(\frac{n_{1.} n_{2.} n_{.1} n_{.2}}{n^3} \right)^{1/2}}$$

(Brownlee, 1965, p. 165)

Table 1
Items Which Entered Significant Prerequisite Relationships

Usage Items 21-42
Expression Items 71-88

Item Number	Skills Objectives
25	Case forms
26	Agreement of subject and verb
32	The past tense
35	Comparative and superlative forms
36	Redundancies
38	Agreement of subject and verb
39	Double negatives
40	The past participle
41	Case forms
71	Verb tenses
76	Sentence structure: Word order in sentences
77	Conciseness
78	Misplaced modifiers
80	Sentence structure; Complete sentences
83	Suitability to purpose
84	Sentence order
85	Sentence function
87	Sentence structure: Word order in sentences
88	Parallel construction

Table 2
Significant Prerequisite Relationships

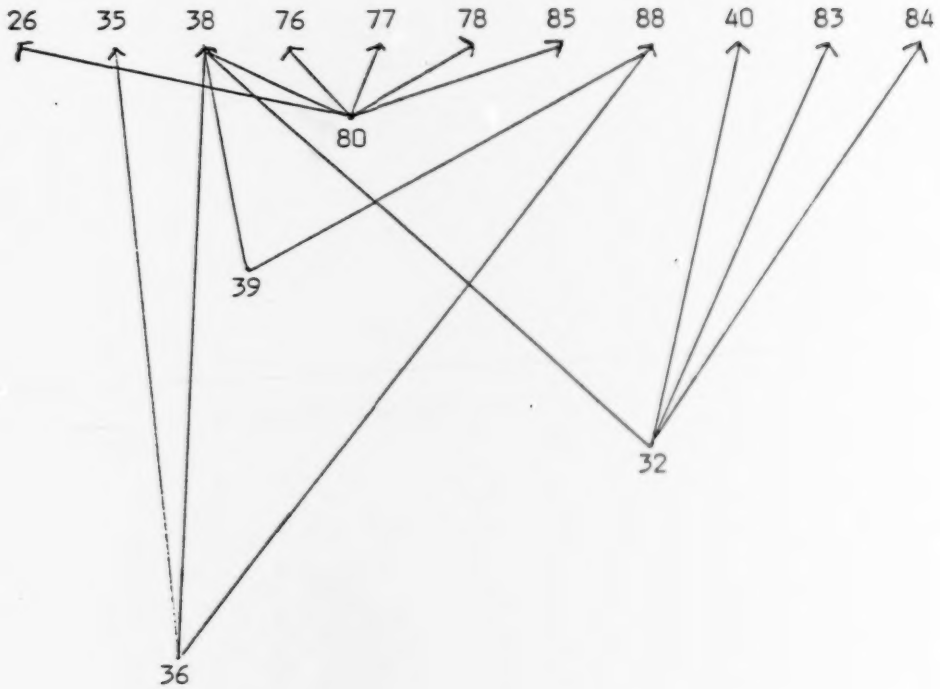
Prerequisite Relationship 1

25 is prerequisite to 87

Prerequisite Relationship 2

71 is prerequisite to 41

Prerequisite Relationship 3



32 is prerequisite to 38 40 83 84

36 is prerequisite to 35 38 88

39 is prerequisite to 38 88

80 is prerequisite to 26 38 76 77 78 85